NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

SPACE SHUTTLE MISSION STS-71

PRESS KIT
JUNE 1995

SHUTTLE MIR MISSION-1

STS-71 INSIGNIA

STS071-S-001 -- *The STS-71 insignia depicts the orbiter Atlantis in the process of the first international docking mission of the space shuttle Atlantis with the Russian Space Station Mir. The names of the 10 astronauts and cosmonauts who will fly aboard the orbiter as shown along the outer border of the insignia. The rising sun symbolizes the dawn of a new era of cooperation between the two countries. The vehicles Atlantis and Mir are shown in separate circles converging at the center of the emblem symbolizing the merger of the space programs of the two space facing nations. The flags of the United States and Russia emphasize the equal partnership of the mission. The joint program symbol at the lower center of the insignia acknowledges the extensive contributions made by the Mission Control Centers (MCC) of both countries. The crew insignia was designed by aviation and space artist, Bob McCall, who also designed the crew insignia for the Apollo-Soyuz Test Project (ASTP) in 1975, the first international space docking mission.*

The NASA insignia design for space shuttle flights is reserved for use by the astronauts and for other official use as the NASA Administrator may authorize. Public availability has been approved only in the form of illustrations by the various news media. When and if there is any change in this policy, which we do not anticipate, it will be publicly announced.

PHOTO CREDIT: NASA or National Aeronautics and Space Administration.

NEWS MEDIA CONTACTS

For Information on the Space Shuttle

Ed Campion Headquarters Washington, DC	Policy/Management	202/358-1780
Rob Navias Johnson Space Center Houston, TX	Mission Operations, Astronauts	713/483-5111
Bruce Buckingham Kennedy Space Center, FL	Launch Processing, KSC Landing Information	407/867-2468
June Malone Marshall Space Flight Center Huntsville, AL	External Tank/SRBs/SSMEs	205/544-0034
Cam Martin Dryden Flight Facility Edwards, CA	DFRC Landing Information	805/258-3448

For Information on STS-71 Experiments & Activities

Rob Navias Johnson Space Center Houston, TX	Mir Rendezvous and Docking	301/286-7277
Debra Rahn NASA Headquarters Washington, DC	International Cooperation	202/358-1639
Mike Braukus NASA Headquarters Washington, DC	Shuttle/Mir Science Operations	202/358-1979

CONTENTS

RELEASE: 95-77

SHUTTLE AND SPACE STATION MIR SET FOR HISTORIC LINK-UP

Twenty years after the world's two greatest spacefaring nations and Cold War adversaries staged a dramatic link-up between piloted spacecraft, the space programs of the United States and Russia will again meet in Earth orbit when Space Shuttle Atlantis docks to the Mir Space Station in June. "This flight heralds a new era of friendship and cooperation between our two countries," said NASA Administrator Daniel S. Goldin. "It will lay the foundation for construction of an international Space Station later this decade."

This flight also will mark America's 100th human space mission. (See chronology of American human space flights on page 45).

The STS-71 mission is the first of seven planned Space Shuttle-Mir link-ups between 1995 and 1997, including rendezvous, docking and crew transfers, which will pave the way toward assembly of the international Space Station beginning in November 1997.

The STS-71 crew will be commanded by Robert L. "Hoot" Gibson who will making his four space flight. Charles J. Precourt will serve as pilot and will be making his second space flight. The three STS-71 mission specialists aboard Atlantis will include Ellen S. Baker, Mission Specialist-1, who will be making her third flight, Gregory J. Harbaugh, Mission Specialist-2, who will be making his third flight and Bonnie Dunbar, Mission Specialist-3, who will be making her fourth space flight.

Also aboard Atlantis will be Cosmonauts Anatoliy Y. Solovyev, making his fourth space flight, and Nikolai M. Budarin, making his first flight. Solovyev and Budarin are designated as the Mir 19 crew and will remain aboard Mir when Atlantis undocks from the nine-year old space station and returns to Earth with the Mir 18 crew.

Launch of Atlantis on the STS-71 mission is currently targeted for June 23, 1995 at approximately 5:06 p.m. EDT from Kennedy Space Center's Launch Complex 39-A. The actual launch time may vary by a few minutes based on calculations of Mir's precise location in space at the time of liftoff due to Shuttle rendezvous phasing requirements. The available launch period, or "window" to launch Atlantis, is approximately five minutes each day.

The STS-71 mission is scheduled to last 10 days, 19 hours, 31 minutes. A 5:06 p.m. launch on June 23 would be followed by a landing at Kennedy Space Center's Shuttle Landing Facility on July 4 at 12:37 p.m. EDT.

STS-71's rendezvous and docking with the Mir actually begins with the precisely timed launch of Atlantis setting it on a course for rendezvous with the Mir station. Over the next two days, periodic firings of Atlantis' small thruster engines will gradually bring the Shuttle to closer proximity to Mir.

Unlike most rendezvous procedures that typically have the Shuttle approaching from directly in front of its target Atlantis will aim for a point directly below Mir, along the Earth radius vector (R-Bar), an imaginary line drawn between the Mir center of gravity and the center of Earth. Approaching along the R-Bar, from directly underneath the Mir, allows natural forces to brake Atlantis' approach more than would occur along a standard Shuttle approach from directly in front of Mir. The R-Bar approach also reduces the small number of jet firings close to the Mir avoiding damage or contamination of its electricity-producing solar panels.

Joint scientific investigations will be carried out inside the Spacelab module tucked in Atlantis' large cargo bay. These investigations will provide more knowledge about the human body and the microgravity environment. Research in seven different medical and scientific disciplines, begun during Mir 18, will conclude on STS-71. Of the 28 experiments being conducted as part of the joint U.S.-Russian cooperative effort, 15 will be performed as part of the STS-71 mission.

The experiments take advantage of the unique microgravity environment, which separates the effects of gravity from the effects of physiologic change occurring from other causes. Researchers will not only enhance knowledge about spaceflight-induced physiologic changes, but also advance understanding of such Earth-based conditions as anemia, high blood pressure, osteoporosis, kidney stones, balance disorders and immune deficiencies.

At the end of joint docked activities, Solovyev and Budarin will assume responsibility for operations of the Mir station. The Mir-18 crew, who have been aboard the station since March 16, are Commander Vladimir Dezhurov, Flight Engineer Gennadiy Strekalov and Cosmonaut Researcher and American astronaut Norm Thagard. They will join the STS-71 crew for the return trip to Earth. Thagard will return home with the American record for a single space flight with more than 100 days in space. The previous record was held by the Skylab-4 crew with 84 days in 1973-1974. Thagard broke the record June 6, 1995.

(END OF GENERAL RELEASE; BACKGROUND INFORMATION FOLLOWS.)

MEDIA SERVICES INFORMATION

NASA Television Transmission

NASA television is available through the Spacenet-2 satellite system. Spacenet-2 is located on Transponder 5, at 69 degrees West longitude; frequency 3880.0 MHz, audio 6.8 MHz.

The schedule for television transmissions from the orbiter and for mission briefings will be available during the mission at Kennedy Space Center, FL; Marshall Space Flight Center, Huntsville, AL; Dryden Flight Research Center, Edwards, CA; Johnson Space Center, Houston, and NASA Headquarters, Washington, DC. The television schedule will be updated to reflect changes dictated by mission operations.

Television schedules also may be obtained by calling COMSTOR 713/483-5817. COMSTOR is a computer data base service requiring the use of a telephone modem. A voice update of the television schedule is updated daily at noon Eastern Time.

Status Reports

Status reports on countdown and mission progress, on-orbit activities and landing operations will be produced by the appropriate NASA newscenter.

Briefings

A mission press briefing schedule will be issued prior to launch. During the mission, status briefings by a Flight Director or Mission Operations representative and when appropriate, representatives from the payload team, will occur at least once each day. The updated NASA television schedule will indicate when mission briefings are planned.

Internet Information

The NASA Headquarters Public Affairs Internet Home Page provides access to the STS-71 mission press kit and status reports. The address for the Headquarters Public Affairs Home Page is: http://www.nasa.gov/hqpao/hqpao_home.html.

Informational materials, such as status reports and TV schedules, also are available from an anonymous FTP (File Transfer Protocol) server at **ftp.hq.nasa.gov/pub/pao**. Users should log on with the user name "anonymous" (no quotes), then enter their e-mail address as the password. Within the /pub/pao directory there will be a "readme.txt" file explaining the directory structure.

Pre-launch status reports from KSC are found under **ftp.hq.nasa.gov/pub/pao/statrpt/ks**c, and mission status reports can be found under **ftp.hq.nasa.gov/pub/pao/statrpt/js**c. Daily TV schedules can be found under **ftp.hq.nasa.gov/pub/pao/statrpt/jsc/tvsked**.

Access by fax

An additional service known as fax-on-demand will enable users to access NASA informational materials from their fax machines. Users calling (202) 358-3976 may follow a series of prompts and will automatically be faxed the most recent Headquarters news releases they request.

Access by Compuserve

Users with Compuserve accounts can access NASA press releases by typing "GO NASA" (no quotes) and making a selection from the categories offered.

STS-71 QUICK LOOK FACTS

Launch Date/Site:	June 23, 1995 /Launch Pad 39A
Launch Time:	5:06 p.m. EDT
Launch Window:	5 minutes
Orbiter:	Atlantis (OV-104), 14th flight
Orbit/Inclination:	213 nautical miles/51.6 degrees
Mission Duration:	10 days, 19 hours, 31 minutes
Landing Date:	July 4, 1995
Landing Time:	12:37 p.m. EDT
Primary Landing Site:	Kennedy Space Center, Florida
Abort Landing Sites:	Return to Launch Site - KSC Transoceanic Abort Landing - Zaragoza, Spain Ben Guerir, Morocco Moron, Spain Abort Once Around - Kennedy Space Center
Crew:	Robert "Hoot" Gibson, Commander (CDR) Charlie Precourt, Pilot (PLT) Ellen Baker, Mission Specialist 1 (MS 1) Greg Harbaugh, Mission Specialist 2 (MS 2) Bonnie Dunbar, Mission Specialist 3 (MS 3) Anatoliy Solovyev, Mir 19 Commander (Ascent only) Nikolai Budarin, Mir 19 Flight Engineer (Ascent only) Vladimir Dezhurov, Mir 18 Commander (Entry only) Gennadiy Strekalov, Mir 18 Flight Engineer (Entry only) Norm Thagard, Mir 18 Cosmonaut-Researcher (Entry only)
EVA Crewmembers:	Harbaugh (EV 1), Baker (EV 2)
Cargo Bay Payload:	Spacelab-Mir Orbiter Docking System
Middeck Payloads:	IMAX
In-Cabin Payloads:	SAREX-II

Developmental Test Objectives/Detailed Supplementary Objectives

DTO 301D:	Ascent Structural Capability Evaluation
DTO 307D:	Entry Structural Capability
DTO 312:	External Tank Thermal Protection System Performance
DTO 414:	APU Shutdown Test
DTO 624:	Radiator Performance
DTO 656:	PGSC Single Event Upset Monitoring Configuration
DTO 700-10:	Orbiter Space Vision System Flight Video Taping
DTO 805:	Crosswind Landing Performance
DTO 832:	Target of Opportunity Navigation Sensors
DTO 1118:	Photographic and Video Survey of Mir Space Station
DTO 1120:	Mated Shuttle and Mir Free Drift Experiment

DSO 487:	Immunological Assessment of Crewmembers
DSO 608:	Effects of Spaceflight on Aerobic and Anaerobic Metabolism
DSO 614:	The Effect of Prolonged Spaceflight on Head and Gaze Stability during Locomotion
DSO 624:	Pre and Postflight Measurement of Cardiorespiratory Responses to Submaxima Exercise
DSO 901:	Documentary Television
DSO 902:	Documentary Motion Picture Photography
DSO 903:	Documentary Still Photography

CREW RESPONSIBILITIES

Payloads and Activities	Prime	Backup
Mir Systems and Payloads	Dunbar	
Spacelab Systems	Precourt	Gibson
Spacelab Payloads	Baker	Dunbar
Orbiter Docking System	Harbaugh	Precourt
Rendezvous	Gibson	Precourt, Harbaugh
Lasers	Harbaugh	Precourt
EVA	Harbaugh, Baker	
IV Crewmember	Precourt	
DTOs/DSOs	Precourt	Gibson
In-Flight Maintenance	Harbaugh	Precourt
Medical Operations	Baker	Gibson
Photography/TV	Harbaugh	Precourt
Earth Observations	Harbaugh	Precourt
SAREX	Precourt	Baker
IMAX	Baker	Gibson
Electronic Still Camera	Baker	

SPACE SHUTTLE ABORT MODES

Space Shuttle launch abort philosophy aims toward safe and intact recovery of the flight crew, orbiter and its payload. Abort modes for STS-71 include:

- Abort-To-Orbit (ATO) -- Partial loss of main engine thrust late enough to permit reaching a minimal 105-nautical mile orbit with the orbital maneuvering system engines.

- Abort-Once-Around (AOA) -- Earlier main engine shutdown with the capability to allow one orbit of the Earth before landing at the Kennedy Space Center, FL.

- Transatlantic Abort Landing (TAL) -- Loss of one or more main engines midway through powered flight would force a landing at either Zaragoza, Spain; Ben Guerir, Morocco; or Moron, Spain.

- Return-To-Launch-Site (RTLS) -- Early shutdown of one or more engines, and without enough energy to reach a TAL site, would result in a pitch around and thrust back toward KSC until within gliding distance of the Shuttle Landing Facility.

PAYLOAD AND VEHICLE WEIGHTS

	Pounds
Orbiter (Atlantis) empty and 3 SSMEs	172,963
Orbiter Docking Equipment	4,016
Spacelab Module and Transfer Tunnel	1,891
Spacelab Payloads	5,739
IMAX Camera	252
Detailed Test and Supplementary Objectives	18
Shuttle System at SRB Ignition	4,511,749
Orbiter Weight at Landing	214,700

STS-71 SUMMARY TIMELINE

Flight Day 1
Ascent
OMS-2 Burn
NC 1 Burn

Flight Day 2
Spacelab Activation
Rendezvous Tool Checkout
Centerline Camera Mounting
NC 2 and 3 Burns

Flight Day 3
Mir Rendezvous Burns
Mir Docking
Hard Mate
Hatch Opening and Welcoming Ceremony
Mir Safety Briefing
Soyuz Seat Liner Exchanges

Flight Day 4
Gift Exchange
Joint Science Investigations

Flight Days 5 and 6
Joint Science Investigations

Flight Day 7
Joint Science Investigations
Joint Crew News Conference
Farewell Ceremony
Off Duty Time

Flight Day 8
Atlantis Undocking and Flyaround
Separation Burn

Flight Day 9
Spacelab Investigations
Prelanding Countermeasures

Flight Day 10
Spacelab Investigations
Pre-Landing Countermeasures

Flight Day 11
Pre-Landing Countermeasures
FCS Checkout
RCS Hot Fire
RCS Hot Fire
Spacelab Stow
Cabin Stow
Recumbent Seat Setup

Flight Day 12
Spacelab Deactivation
Deorbit Prep
Deorbit Burn
KSC Landing

STS-71 ORBITAL EVENTS SUMMARY

Event	MET
Launch	0/00:00
OMS-2	0/00:43
Spacelab Activation	0/16:00
TI Burn	1/14:17
Mir Docking	1/17:22
Hard Mate	1/17:36
Hatch Opening, Welcoming	1/18:58
Gift Exchange	2/14:15
Crew News Conference	5/20:09
Farewell Ceremony	5/21:55
Atlantis Undocking and Flyaround	6/16:11
Separation Burn	6/17:30
Deorbit Burn	10/18:26
KSC Landing	10/19:31

U.S./RUSSIAN SPACE COOPERATION

The International Space Station Program is Underway

The international Space Station will be the preeminent, permanent orbiting science institute in space. It is being developed and assembled in three phases, each designed to maximize joint space experience and permit early utilization and return on a large joint investment involving 15 nations.

In Phase I, Americans and Russians will work together in laboratories on Mir and the Shuttle. They will conduct joint spacewalks and practice space station assembly by adding new modules to Mir. American astronauts will live and work on Mir for months beside their Russian counterparts, amassing the first U.S. long-duration space experience since Skylab (1973-1974).

International Space Station Phase I began with Russian cosmonaut Sergei Krikalev's flight aboard the Space Shuttle Discovery in February 1994 on STS-60. In February 1995, on the STS-63 mission, Discovery flew around the Russian Mir space station with cosmonaut Vladimir Titov aboard. During the fly around, Discovery stopped 37 feet from Mir -- a rehearsal for the first docking between Space Shuttle Atlantis and Mir in June 1995.

In March 1995, U.S. astronaut Dr. Norman Thagard flew to Mir for a three-month stay with two Russian cosmonauts, arriving there March 16. Thagard and his Russian crew mates will return to Earth aboard Atlantis, which also will deliver a new Russian crew to the Mir station.

Phase I Impact on Phases II and III

The goal of Phase I is to lay the groundwork for international Space Station Phases II and III. Phase II beginning in 1997 will place in orbit a core space station with a U.S. laboratory module, the first dedicated laboratory on the station.

The U.S. laboratory will be put to work during utilization flights beginning in 1999 with Phase III, while assembly continues. Phase III ends when assembly is complete (scheduled for mid-2002). At that time, astronauts and cosmonauts from many countries will commence full time space research on the international Space Station.

Phase I is contributing to the success of Phases II and III in four major areas:

- Americans and Russians are working together on Earth and in space, practicing for the future international Space Station
- Integration of U.S. and Russian hardware, systems, and scientific aims over a long period of time
- Risk reduction-mitigation of potential surprises in operations, spacecraft environment, spacewalks, and hardware exchange
- Early initiation of science and technology research

The Space Station Mir

Mir represents a unique capability -- an operational space station that can be permanently staffed by two or three cosmonauts. Visiting crews have raised Mir's population to six for up to a month.

Mir is the first space station designed for expansion. The 20.4-ton Core Module, Mir's first building block, was launched in February 1986. The Core Module provides basic services (living quarters, life support, power) and scientific research capabilities. It has two axial docking ports, fore and aft, for Soyuz-TM manned transports and automated Progress-M supply ships, plus four radial berthing ports for expansion modules.

To date, the Russians have added three expansion modules to the Mir core:

- **Kvant**. Berthed at the core module's aft axial port in 1987, the module weighs 11 tons and carries telescopes and equipment for attitude control and life support.

- **Kvant 2**. Berthed at a radial port since 1989, the module weighs 19.6 tons and carries an EVA airlock, two solar arrays, and life support equipment.

- **Kristall**. Berthed opposite Kvant 2 in 1990, Kristall weighs 19.6 tons and carries two stowable solar arrays, science and technology equipment, and a docking port equipped with a special androgynous docking mechanism designed to receive heavy (up to about 100 tons) spacecraft equipped with the same kind of docking unit. The androgynous unit was originally developed for the Russian Buran Shuttle program. The Russians will move Kristall to a different radial Mir port to make room for the new Spektr module, which was launched on May 20. Atlantis will use the androgynous docking unit on Kristall for the first Shuttle-Mir docking in June 1995.

Three more modules, all carrying U.S. equipment, will be added to Mir in 1995 for international Space Station Phase I:

- **Spektr**. Launched on a Russian Proton rocket from the Baikonur launch center in central Asia, Spektr was lofted into orbit on May 20. The module was berthed at the radial port opposite Kvant 2 after Kristall was moved out of the way. Spektr carries four solar arrays and scientific equipment (including more than 1600 pounds of U.S. equipment).

- **Docking Module**. The module will be launched in the payload bay of Atlantis and berthed at Kristall's androgynous docking port during the STS-74 mission in Fall 1995. The Docking Module will provide clearance for future Shuttle dockings with Mir and will carry two solar arrays -Ð one Russian and one jointly developed by the U.S. and Russia -- to augment Mir's power supply.

- **Priroda**. Launch on a Russian Proton rocket is scheduled for December 1995. Priroda will berth at the radial port opposite Kristall and will carry microgravity research and Earth observation equipment (including 2,200 pounds of U.S. equipment). In late 1995, after Priroda is added, Mir will have a mass of more than 100 tons. The station will be made up of seven modules launched separately and brought together in space over 10 years. Experience gained by Russia during Mir assembly provides valuable experience for international Space Station assembly in Phases II and III.

PHASE I SHUTTLE MISSION SUMMARIES

STS-60

Launch: Feb. 3, 1994
Landing: Feb. 11, 1994

This mission inaugurated international Space Station Phase I. Veteran Russian cosmonaut Sergei Krikalev served as a mission specialist aboard Discovery. He conducted experiments beside his American colleagues in a Spacehab laboratory module carried in Discovery's payload bay.

STS-63

Launch: Feb. 3, 1995
Landing: Feb. 11, 1995

Discovery maneuvered around Mir and stopped 37 feet from the Kristall module's special androgynous docking unit, which Atlantis will use to dock with Mir on the STS-71 mission. Cosmonauts on Mir and astronauts on Discovery beamed TV images of each other's craft to Earth. Cosmonaut Vladimir Titov served on board Discovery as a mission specialist, performing experiments beside his American colleagues in a Spacehab module in the orbiter's payload bay.

For a time it appeared that minor thruster leaks on Discovery might keep the two craft at a pre-planned contingency rendezvous distance of 400 feet. However, mission control teams and management in Kaliningrad and Houston worked together to determine that the leaks posed no threat to Mir, so the close rendezvous went ahead. The minor problem became a major confidence builder and joint problem-solving experience for later international Space Station phases.

STS-71

Planned launch date: June 23, 1995, 5:06 p.m., EDT
Planned rendezvous date: June 26, 1995
Planned landing date: July 4, 1995, 12:37 p.m., EDT

Atlantis will launch seven crew members -- five U.S. astronauts and two Russian cosmonauts -- and, in its payload bay, a Spacelab module and an Orbiter Docking System for docking with Mir. The Orbiter Docking System is a cylindrical airlock with a Russian-built androgynous docking mechanism on top. The Orbiter Docking System will be carried on all docking missions. For STS-71, Atlantis will dock with an identical androgynous unit on Mir's Kristall module.

The Space Shuttle will be used for the first time to change a space station crew, a task which will become a routine part of its duties in later international Space Station phases. Atlantis will drop off cosmonauts Anatoliy Solovyev and Nikolai Budarin, and pick up Gennadiy Strekalov, Vladimir Dezhurov, and U.S. astronaut Norman Thagard for return to Earth. They were launched from Russia in the Soyuz-TM 21 spacecraft on March 14.

Thagard and his Russian colleagues will be completing a three-month stay on Mir. Thagard is the first U.S. astronaut to have a long-duration stay on-orbit since the last U.S. Skylab mission in 1974. In fact, his mission broke the record for time on-orbit for a U.S. astronaut on June 6.

The joint crew will carry out experiments similar to those planned for international Space Station Phases II and III. Atlantis will remain docked to Mir for five days.

STS-74
Planned launch: October 1995

Atlantis will carry the Russian-built Docking Module, which has multi-mission androgynous docking mechanisms at top and bottom. During the flight to Mir, the crew will use the orbiter's Remote Manipulator System robot arm to hoist the Docking Module from the payload bay and berth its bottom androgynous unit atop Atlantis' Orbiter Docking System. Atlantis will then dock to Kristall using the Docking Module's top androgynous unit. After two days, Atlantis will undock from the Docking Module's bottom androgynous unit and leave the Docking Module permanently docked to Kristall, where it will improve clearance between the Shuttle and Mir's solar arrays during subsequent dockings.

Atlantis will deliver water, supplies, and equipment, including two new solar arrays -- one Russian and one jointly-developed -- to upgrade the Mir. It will return to Earth experiment samples, equipment for repair and analysis and products manufactured on the station.

STS-76
Planned launch: March 1996

Atlantis will deliver U.S. astronaut Shannon Lucid to Mir for a three-month stay. The orbiter will carry a Spacehab module in its payload bay and will remain docked to the Russian station for five days. Astronauts Linda Godwin and Rich Clifford will conduct the first U.S. spacewalk outside the Mir to attach four experiments to the station's docking module.

STS-79
Planned Launch: August 1996

The Space Shuttle will pick up Lucid for her return to Earth and deliver her replacement, U.S. astronaut Jerry Linenger, to Mir for approximately three months. U.S. astronauts will perform a spacewalk during the five-day docked phase. Atlantis will carry a Spacehab double module.

STS-81
Planned Launch: December 1996

Linenger will return to Earth and another astronaut will take up residence on Mir. Two Russians or an American and a Russian will perform U.S. experiments as part of a spacewalk during or after the five-day docked phase. Atlantis will carry a Spacehab double module.

STS-84
Planned Launch: May 1997

The astronaut delivered on STS-81 will be picked up and another astronaut dropped off. Atlantis will carry a Spacehab double module and will remain docked to Mir for five days.

STS-86
Planned Launch: September 1997

Atlantis will pick up the astronaut dropped off on STS-84 and will deliver a joint U.S.-Russian solar dynamic energy module. As many as two spacewalks by U.S. astronauts and Russian cosmonauts will be needed to deploy the energy module outside Mir. The solar dynamic system will heat a working fluid that will drive a turbine, generating more electricity than current photovoltaic solar arrays. The Mir solar dynamic energy module will test the system for possible use on the international Space Station. In addition, developing the solar dynamic energy module will provide joint engineering experience.

MIR RENDEZVOUS AND DOCKING

STS-71's rendezvous and docking with the Russian space station Mir actually begins with the precisely timed launch of Atlantis on a course for the station. Over the next two days, periodic small engine firings will gradually bring Atlantis to a point eight nautical miles behind Mir. At that time, on the third day of the flight, a Terminal Phase Initiation (TI) burn will be fired, and the final phase of the rendezvous will begin. Atlantis will close the final eight nautical miles to Mir during the next 90-minute orbit.

As Atlantis moves in, the Shuttle's rendezvous radar system will begin tracking Mir and providing range and closing rate information to the Shuttle crew. As Atlantis nears Mir, the Trajectory Control Sensor, a laser ranging device mounted in the payload bay, will supplement the Shuttle's onboard navigation information by supplying additional data on the range and closing rate.

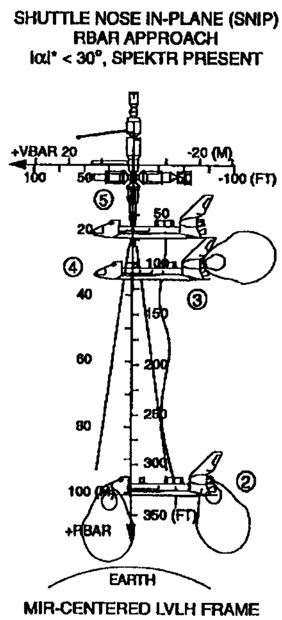
As Atlantis closes the final eight nautical miles, the Shuttle will have the opportunity for four small successive engine firings to fine-tune its approach using its onboard navigation information. Unlike most Shuttle rendezvous procedures, Atlantis will aim for a point directly below Mir, along the Earth radius vector (R-Bar), an imaginary line drawn between the Mir center of gravity and the center of Earth.

Approaching along the R-Bar, from directly underneath the Mir, allows natural forces to brake the approach more than would occur along a standard Shuttle approach from directly in front of Mir. The R-Bar approach also reduces the small number of jet firings close to the Mir's solar panels. The manual phase of the rendezvous will begin just as Atlantis reaches a point about a half-mile below Mir when Commander Gibson takes the controls. Gibson will fly the Shuttle using the aft flight deck controls as Atlantis begins moving up toward Mir.

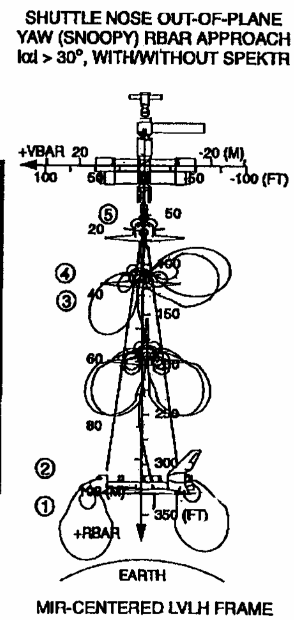
Because of the approach from underneath Mir along the R-bar, Gibson will have to perform very few braking firings. However, if such firings are required, the Shuttle's jets will be used in a mode called Low-Z, a technique that uses slightly offset jets on Atlantis' nose and tail to slow the spacecraft rather than firing jets pointed directly at Mir. This technique avoids contamination of the space station by exhaust from the Shuttle steering jets.

Using a centerline camera fixed within the docking system in the payload bay, Gibson will center the Shuttle's docking mechanism with the Mir docking device on the end of the Kristall science module, continually refining this alignment as he approaches to within 300 feet of the station. If necessary, Gibson will then realign Atlantis by rotating the Shuttle to the correct orientation for docking. A 90-degree yaw maneuver of Atlantis may be required.

RBAR CORRIDOR APPROACH FROM 270 FT TO DOCKING



	PET (MM:SS)	R (FT) (M)	EVENT
1	-48:00	270 80	PERFORM SNOOPY MNVR (|α| > 30°)
2	-38:00	270 80	BEGIN APPROACH
3	-15:00	50 15	COAST TO 30 FT STATIONKEEPING PERFORM ANGULAR ALIGNMENT MNVR
4	-6:00	30 9	RESUME APPROACH RDOT = -0.07 FT/S SWITCH TO NORM Z
5	0:00	0 0	DOCKING MET = 1/17:26



* - NOTE: $\alpha = -\beta$

Plans call for Atlantis to spend 90 minutes station-keeping 250 feet from Mir while flight directors in Houston and at the Russian Mission Control Center outside Moscow review the status of their respective vehicles.

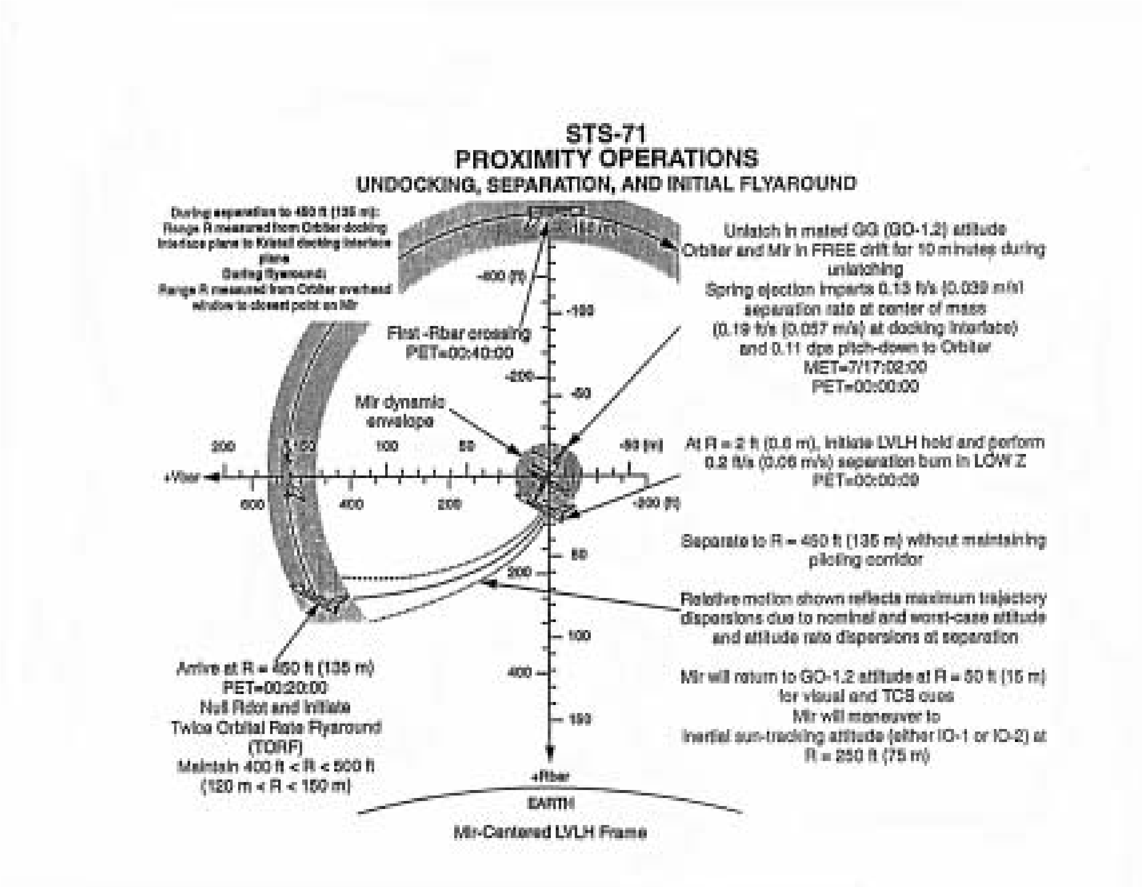
Once a "go" is given for the final approach, Gibson will maneuver Atlantis at a rate of 0.1 feet per second until the orbiter is just 30 feet away. During the station-keeping period and the final approach, Gibson will radio the Mir crew by ship-to-ship communications, providing Shuttle status and keeping them informed of major events from that point on, including confirmation of contact, capture and conclusion of damping. Damping, the halt of any relative motion between the spacecraft after docking, is performed by springs within the docking device.

Undocking, Separation and Mir Fly Around

After over 100 hours of docked operations, the hatches will be closed on both Atlantis and the Mir, and the vestibule in the Shuttle's docking system will be depressurized. The initial separation will be performed by springs that will slightly push the Shuttle and the Mir away from each other on a command sent to the docking mechanism from an aft flight deck control panel in Atlantis. Both the Mir and Atlantis will be in a mode called "free drift" during the undocking, a mode that has the steering jets of each spacecraft shut off to avoid any inadvertent firings.

Once the docking mechanism springs have pushed Atlantis. away to a distance of about two feet from Mir, the docking devices will be clear of one another, and Gibson will turn Atlantis' steering jets back on. He will immediately lightly fire the Shuttle's jets in the Low-Z mode to begin very slowly moving away from Mir.

Atlantis will move away from Mir to a distance of about 400 feet, where Gibson will begin a fly around of the station. At that distance, Atlantis will circle Mir a little more than one-and-a-half times to gather detailed engineering pictures and video of the space station before firing its jets again to conclude the joint mission.



ORBITER DOCKING SYSTEM

Atlantis and Mir will be linked by an orbiter docking system, jointly developed by Rockwell's Space Systems Division, Downey, CA, and RSC Energia, Kaliningrad, Russia, under a July 1992 modification to an existing Rockwell-NASA JSC Shuttle contract. The $95.2-million orbiter docking system consists of an external airlock, a supporting truss structure, a docking base, avionics required to operate the system, and a 632-pound Russian-built docking mechanism, called the androgynous peripheral assembly system (APAS), which is mounted on top of the airlock and docking base. The APAS was procured under a June 1993 subcontract to RSC Energia.

Atlantis received extensive wiring changes to accommodate the new system, which measures nearly 15 feet wide, 6-1/2 feet long, and 13-1/2 feet high and weighs more than 3,500 pounds. It is installed near the forward end of the orbiter's payload bay and is connected by short tunnels to the existing airlock inside the orbiter's pressurized crew cabin and the pressurized Spacelab module, which is aft of the airlock in the payload bay.

The APAS is a hybrid version of the docking system the Russians used in 1975 for the Apollo-Soyuz Test Project. It differs from its predecessor in several key respects. First, it is much more compact, with an overall external diameter of 60 inches compared to 80 inches on ASTP, although the inner egress tunnel diameter remains approximately the same. Second, the APAS docking mechanism has 12 structural latches, compared to eight on the ASTP. Third, the APAS guide ring and its extend/retract mechanism are packaged inside the egress tunnel rather than being outside of the mechanism as they were on ASTP. Finally, the three guide petals on the APAS point inboard rather than outboard.
Both Atlantis and Mir are equipped with an APAS, which consists of a three-petal androgynous capture ring mounted on six interconnected ball screw shock absorbers, which operate like a sophisticated car suspension system. The absorbers arrest the relative motion of the two vehicles and prevent them from colliding.

When the Shuttle crew is ready to begin the docking maneuver, it places the orbiter's docking mechanism in the active mode, or ready-to-dock configuration. In this configuration, the capture ring is extended outward about 11 inches, and the mechanism's five locking devices, called fixators, are disengaged. The docking system of the target vehicle (Mir), also referred to as the passive vehicle, is in a non-operational, stowed mode.

The orbiter crew's primary visual aid for aligning the docking mechanisms during rendezvous is a television camera mounted inside the airlock of the orbiter docking system. The camera views a target at the center of the Mir mechanism through a window in the upper hatch.

Docking begins when the orbiter is maneuvered to bring the interfaces of the active docking mechanism in contact with Mir's passive mechanism. At this point, the maximum allowable axial rate of approach of the two vehicles is 0.2 foot per second. Minor misalignments of the two mechanisms of up to eight inches and five degrees are corrected as the orbiter interface is displaced and rotated so the capture ring can latch onto the opposing androgynous interface ring. This rotation is produced by the relative velocity of the two vehicles. If the alignments are exceeded, the passive half will not be captured, and the two vehicles will simply separate. Further docking attempts can then be made.

Soft latching occurs when the capture ring alignment is complete and the interfaces are aligned. Each of the petals on Atlantis' APAS is equipped with two capture latches. The capture latch assemblies, which operate independently, grapple body mounts on the Mir APAS.

The latches are designed to allow the vehicles to separate safely if only one or two of the latch assemblies engage. Once all the latches engage, all possible axes of rotation between the interfaces are removed, and Mir is captured.

The docking of these two massive vehicles is complicated by the orbiter's large center-of-mass offset from the docking mechanism's longitudinal axis, which significantly reduces the effective mass of the active vehicle at the docking interface, making capture more difficult. The orbiter's momentum provides the force required by the docking mechanism to overcome the relative misalignments between the vehicles at the docking interfaces, and preprogrammed firings of the orbiter's nose and tail thrusters assist in the capture. The center of mass offset also causes relative rotation after contact, which complicates the attenuation process.

Five seconds after capture, dampers designed to reduce relative vehicle motion are activated for 30 seconds. Before the dampers are activated, a load-limiting clutch prevents either vehicle from being overloaded. The dampers are deactivated to allow the dampers to align the vehicles.

After the relative motion of the two vehicles has subsided, the retraction phase of the docking process then begins. During this phase, the latched capture ring and passive vehicle are pulled into the orbiter mechanism. The five engaged fixators make the capture ring rigid and prevent relative vehicle misalignments from accumulating during retraction.
Structural latching occurs at the completion of the capture ring retraction process. Twelve active structural latches located at the structural interface are grouped into two separate activated gangs of six latches each. A passive, immobile hook is located next to each active latch. The Mir mechanism also has these latches and hooks. In the process of structurally latching the orbiter and Mir, latch actuator motors deploy the orbiter's active latches, which hook onto Mir's passive hooks. The actuator drives the first hook directly, and a cable transmits power to the remaining five slave hooks. The hooks are driven beyond the point where the hook is overcenter. The overcenter hooks carry the sealing load, rather than the cables. Mir's active latches could also be used to hook onto the orbiter's passive hooks as a backup procedure. The entire docking process nominally will be completed in less than one hour. The final portion of the process, after capture, takes approximately 15 minutes.

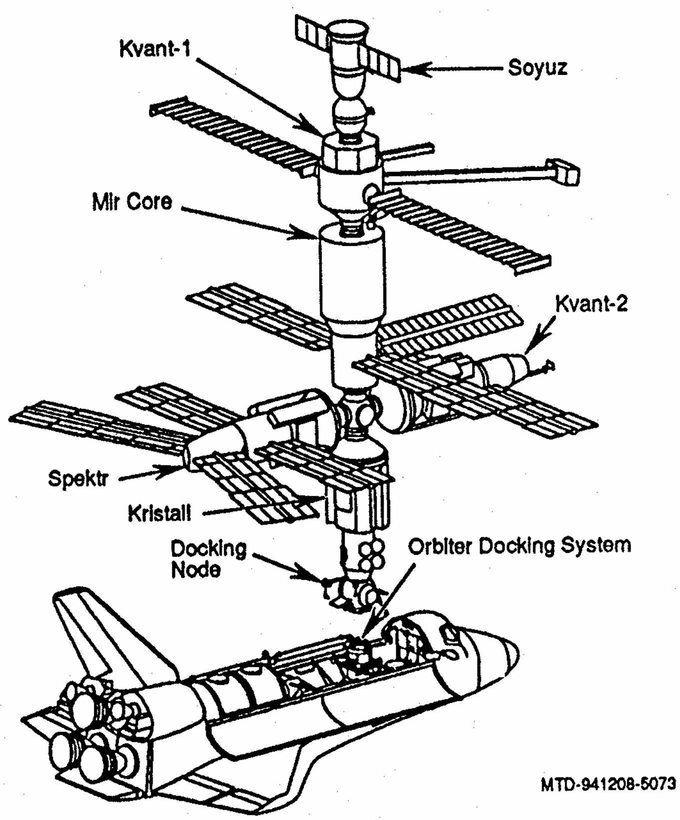
While the vehicles are structurally attached, the orbiter docking system provides a shirt-sleeve environment for transferring crew members and equipment between the orbiter and Mir.

At the end of the mission, the latches are unhooked after the docking base is depressurized, and preloaded separation springs "push" the vehicles apart at low velocity. After it reaches a safe distance from Mir, the orbiter performs a separation maneuver.

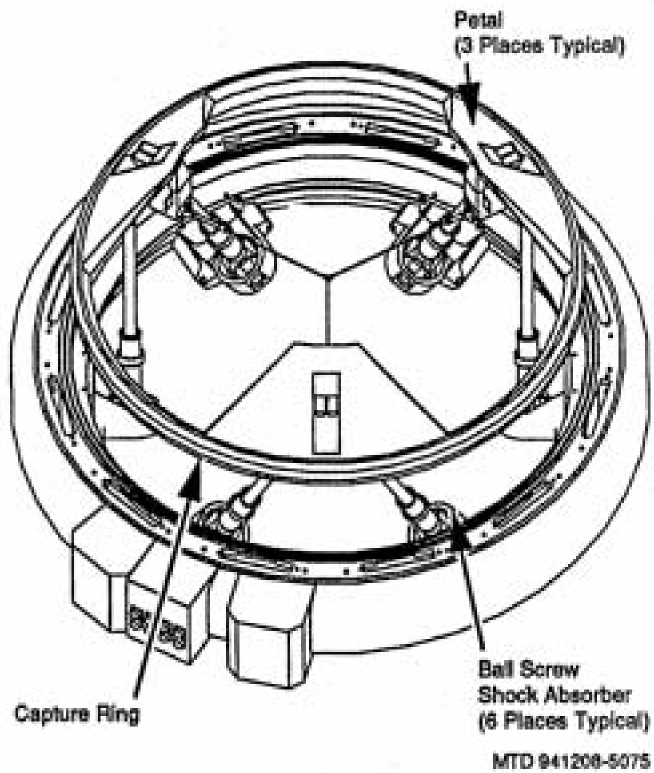
The requirement that the ODS be at least dual fault tolerant to allow demating (and subsequent orbiter payload bay door closure) is achieved with two independent (no common cause failure mode) methods. If the primary separation method fails, pyrotechnic charges can be used to shear each of the orbiter's 12 active latch retention bolts and permit the springs to separate the vehicles. Each bolt has redundant power supplies. When fired, the pyrotechnic charges fracture the bolts, allowing the latch hook to rotate about an independent rotation point to release the mating hook. Hook rotation is powered by both the pyrotechnic charge and the off-center force created by the Belleville washers on the mating passive hook. A spring-loaded pin prevents hook rebound.

A third method is available if the second also fails. This method requires two astronauts to perform a spacewalk to remove the 96 bolts that hold the docking base on the upper flange of the external airlock. For an EVA to be considered as an option, the station-to-orbiter interface must be rigidized to prevent relative motion between the orbiter and Mir during vehicle attitude control firings. In the EVA procedure, the capture ring would be extended to recapture the Mir, and either the orbiter or the Mir active structural hooks would be engaged to reestablish the interface. The EVA crew would then egress the vehicle and perform the 96-bolt removal procedure.

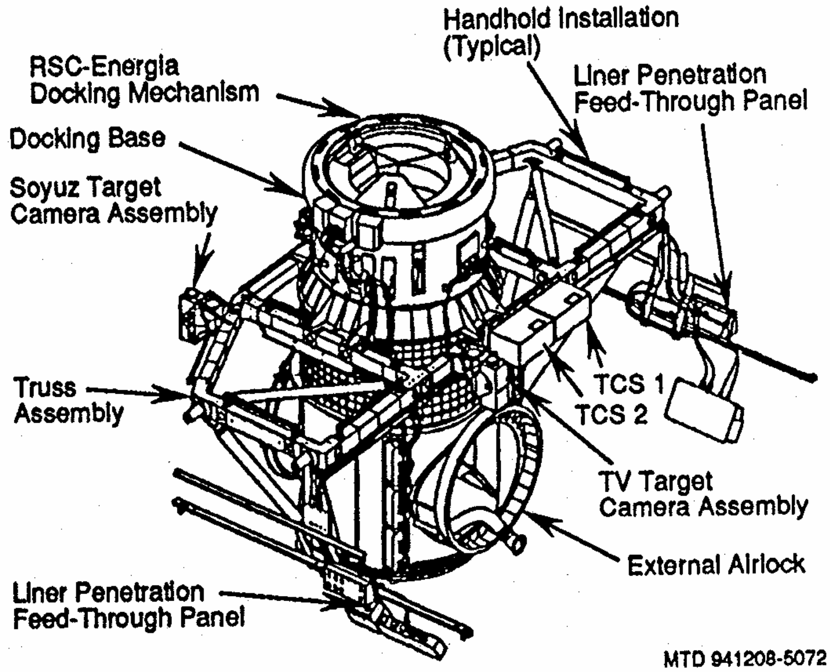
The Energia docking mechanism design and hardware have undergone extensive testing to develop and qualify the system for the Mir mission. A number of tests were performed in Energia's six-degree-of-freedom test facility to quantify the limits of the mechanism's capture capability. A production unit was subjected to vibration, thermal, and life cycle testing to verify the design. Acceptance tests of the flight unit were conducted to verify the build process. An integrated checkout of the entire system was performed after the orbiter docking system was assembled. Another was performed after it was installed in Atlantis at the Kennedy Space Center. Many firings of the pyrotechnic bolts alone and as part of latch subassemblies were conducted to certify the backup separation system.



Orbiter Docking System Mating to Mir Space Station



Active RSC-Energia Docking Mechanism in Ready-to-Dock Configuration



Orbiter Docking System

SHUTTLE-MIR SCIENCE

Joint scientific investigations by the two premier spacefaring nations continue with the flight of STS-71, the Spacelab-Mir mission, providing more knowledge about the human body and the microgravity environment.

Research in seven different medical and scientific disciplines begun during Mir 18 will conclude on STS-71. Of the 28 experiments being conducted as part of the joint United States-Russian cooperative effort, 15 will be performed as part of the STS-71 mission.

With Atlantis docked to Mir, data and samples collected during the Mir 18 tenure will be transferred to Atlantis for the return trip to Earth. In addition, 11 experiments will remain on Mir to be conducted by the Mir 19 crew.

The metabolic research on STS-71 includes studies of the cardiovascular and pulmonary systems; neurosensory research; hygiene, sanitation, and radiation research; behavior and performance research; fundamental biology research; and microgravity research.

Metabolic Research

Six experiments will examine a wide range of physiologic responses as investigators strive to understand how the body's mechanisms work in space, and how gravity affects the body on Earth.

STS-71 will continue and expand the studies begun on the Mir to study human metabolism and endocrinology and to determine how fluids redistribute themselves in the body, how microgravity affects bone density and red blood cell production. In addition, crew members aboard Atlantis will participate in studies designed to determine if prolonged exposure to microgravity affects the body's ability to mount an antibody response, and whether immune cells are altered by exposure to microgravity.

Cardiovascular and Pulmonary Research

Deconditioning of the cardiovascular and pulmonary system, with the occurrence of orthostatic intolerance (or lightheadedness upon standing) observed in returning crew members of long duration spaceflight is of primary interest to researchers. Researchers will measure changes in blood volume during flight and the pooling of blood in the legs and abdomen upon reentry.

Exercise and the use of both Russian and American lower body negative pressure units will be used as tests and evaluated as countermeasures for their ability to protect those returning crew members. Using a device to mimic increasing and decreasing arterial pressure by applying suction and pressure to the neck, crew members will provide information about heart rate response to this changing pressure stimulus during and after space flight.

The returning Mir 18 crew members will venture back to Earth in a reclining position. The changes in heart rate, blood pressure, voice and posture will be monitored during the reentry portion of STS-71. After landing, they will perform a "stand test" to measure the extent of their orthostatic intolerance following a prolonged stay on orbit.

Neurosensory Research

Investigations begun during Mir 18 focused on the mixed messages the body receives when the brain integrates nerve impulses from the eyes, inner ear, muscles and joints. The brain can no longer rely on gravity as a constant in determining body position and orientation. Two of these studies seek to enhance our understanding of how humans adapt to spaceflight and readapt to Earth's environment.

STS-71 will take a further look at neuromuscular function and muscle deconditioning during extended spaceflights. Crew members will measure muscle tone, strength and endurance by electromyography and utilization of oxygen during treadmill and other exercise.

Hygiene, Sanitation, and Radiation Research

Microgravity is not the only environmental challenge facing spaceflight crews. Recycled air and water, possible microbial contamination, and radiation exposure all must be studied and understood to ensure health in closed living systems.

Two investigations will look at the radiation environment experienced during an extended stay in space, and two others will look at the presence of microbes or trace chemicals found in the air and water consumed by the astronauts.

Microbial samples from both Mir and Atlantis, as well as samples from the astronauts themselves, will be studied to see if microgravity or the characteristics of the closed environment will affect microbial physiology or their interactions with the crew on orbit. Samples of air and water collected during the Mir 18 mission and during STS-71 also will be analyzed for any traces of atmospheric and water contaminants.

Behavior & Performance Research

Data from tests to study the long-term effects of microgravity on muscle coordination and mental acuity, collected during more than three months on Mir 18, will be returned to Earth aboard Atlantis. A Russian spacecraft control simulator used before, during and after flight, will allow researchers to measure crew member's functional state and manual control performance.

Fundamental Biology Research

Microgravity will be used as a research tool to study biological development.

STS-71 will study how weightlessness affects embryo development by returning to Earth a set of pre-fertilized quail eggs incubated on board Mir. The incubation process was stopped at various stages of development, and the embryos placed in a fixative solution for later analysis.

Improved sensors will be carried to orbit by Atlantis to be added to the Mir station greenhouse by the Mir 19 crew. The updated greenhouse will then be ready for plant experiments on future NASA-Mir missions.

Microgravity Research

Living organisms are not the only things affected by microgravity. Inanimate objects and materials, including crystals, are affected by this unique environment. The presence of gravity on Earth makes it difficult to observe the basic processes of crystal growth. STS-71 will carry a protein crystal growth experiment into orbit. It will be transferred to Mir where the experiment will continue under the watchful eyes of the Mir 19 crew.

With the experiment in space for an extended duration, researchers will be able to observe the crystallization of a number of large proteins that may be used in basic biological research, pharmacology and drug development.

As the protein crystal growth experiments take place on Mir, the Space Acceleration Measurement System flown frequently on board the Shuttle, will be in place on board Mir to measure any motion caused by crew activity or engine firings. This information will aid scientists in determining the best location to house protein crystal growth experiments in order to produce the purest possible samples.

Protein Crystal Growth Experiment

Principal Investigator:
Dr. Alexander McPherson
University of California, Riverside
Riverside, CA

STS-71 will carry several hundred protein samples, frozen in a thermos-bottle-like vacuum jacket or dewar, to the Mir space station. After they thaw, the proteins will crystallize until the dewar is retrieved by the STS-74 crew in November.

Proteins are important, complex biological molecules which serve a variety of functions in all living organisms. Determining their molecular structure will lead to greater understanding of their functions within those organisms. Many proteins can be grown as crystals and their structures analyzed by X-Ray diffraction. However, some crystals grown in Earth's gravity often have internal defects that make such analysis difficult or impossible.

As demonstrated on Space Shuttle missions since 1985, certain protein crystals grown in space are larger, have fewer defects and have greater internal order than their Earth-grown counterparts. The two-week-long U.S. Microgravity Laboratory (USML-1) mission in 1992 demonstrated that extended duration in orbit is especially valuable in protein crystal growth.

The months-long growing time aboard Mir should produce large protein crystals of sufficient size and quality to compare with corresponding crystals grown in Earth-based laboratories. The Mir experiment will be used to evaluate the effectiveness of flash-frozen bath and liquid-liquid diffusion techniques for growing protein and virus crystals on long-duration space missions. Experience gained will help shape PCG investigations to be conducted aboard the international Space Station.

In liquid-liquid diffusion, a protein solution and a precipitant fluid are brought into contact but not mixed. Over time, the fluids will diffuse into each other through random motion of molecules. The gradual increase in concentration of the precipitant within the protein solution causes the proteins to crystallize. This occurs very slowly, allowing formation of large crystals with highly uniform internal order -- essential for X-Ray diffraction analysis of crystals. Liquid-liquid diffusion is difficult on Earth because differences in solution densities allow mixing by gravity-driven thermal convection. In addition, the greater density of the crystals allows them to settle into inappropriate parts of the cell.

A total of 46 different proteins, selected by a committee of scientists, are candidates for the Mir PCG experiment. The various samples will range in size from about five to 5,000 microliters.

Equipment for the Mir experiment is simple and requires virtually no crew activity. A total of 250 to 500 samples (depending on the mix of tubes and sizes chosen) will be divided into three bundles. The bundles will be stacked in a sealed aluminum cylinder, 3.5 inches (8.9 cm) wide and 13.5 inches (34.3 cm) long. The cylinder then will be placed inside an aluminum vacuum jacket, or dewar, lined with a calcium silicate absorbent. The absorbent will be filled with liquid nitrogen at -320 degrees Fahrenheit (-196 degrees Celsius) to flash freeze the samples, blocking diffusion and crystal growth until thawing occurs aboard Mir.

Because the dewar has no active refrigeration, the liquid nitrogen will begin warming slowly and boiling off when the dewar is filled before launch. After Atlantis docks with Mir, the crew will secure the dewar in a quiet area of the Mir station to minimize vibration. The liquid nitrogen will continue to boil off into Mir's oxygen/nitrogen atmosphere. In orbit, the samples will thaw after the nitrogen evaporates (over a period of 10 days). This ensures that all crystallization will occur in the microgravity environment of space. The proteins will crystallize over the next few months at cabin temperature, 72 degrees Fahrenheit (22 degrees Celsius). The dewar will remain within a few degrees of that temperature through STS-74 landing and return of the samples to science investigators.

PROTOCOL ACTIVITIES DURING THE FIRST SHUTTLE/MIR DOCKING MISSION

The protocol events planned while STS-71 and Mir are docked include: astronaut/cosmonaut handshakes, a welcoming ceremony, gift exchanges and a farewell ceremony -- all are planned for live NASA Television coverage.

On flight day three, about 90 minutes after the two craft are docked, the hatch will open and Russian and U.S. commanders will enter the docking tunnel, shake hands and exchange greetings. Immediately following will be the welcoming ceremony, where all crewmembers will meet in Mir's core module for introductions and toasts to successful space missions.

With the Russian and U.S. flags as a backdrop, the STS-71 and Mir crews will exchange gifts on flight day four in the Shuttle's Spacelab module. Gifts include a halved pewter medallion bearing a relief image of a docked Shuttle and Mir space station; the two halves will be joined during the ceremony. A 1/200th-scale model of the Shuttle and the Mir also will be joined. These gifts will be presented to the U.S. and Russian Heads of State and the leaders of the two space agencies after the mission.

A proclamation will be signed by both crews certifying the date and time of the docking. The document also states:

> **"The success of this endeavor demonstrates the desire of these two nations to work cooperatively to achieve the goal of providing tangible scientific and technical rewards that will have far-reaching effects to all people of the planet Earth."**

A farewell ceremony will take place aboard Mir. Crews are expected to share personal views of this unique experience with each other, before returning to their respective spacecraft to prepare for undocking.

IMAX

NASA is using the IMAX film medium to document its space activities and better translate them to the public. This system, developed by IMAX Systems, Corp., Toronto, Canada, uses specially designed 70 mm film cameras and projectors to record and display very high definition, large screen pictures.

NASA has flown IMAX camera systems on many Shuttle missions, including the recent STS-63 Shuttle-Mir rendezvous. NASA will continue to use IMAX cameras to collect footage for future productions. Film from previous missions was used to create the productions The Dream is Alive and The Blue Planet.

In-Cabin IMAX Camera Equipment

The IMAX system consists of a camera, lenses, rolls of film, lights, and other equipment that is necessary for filming. The IMAX and supporting equipment are stowed in the middeck for in-cabin use. The IMAX uses two film magazines that can be interchanged as part of the operation; each magazine runs for approximately three minutes. After the crew has used both magazines, they can reload with new film. Lenses are changed as necessary based on the shot. The IMAX will be installed on the orbiter approximately seven days prior to launch.

SHUTTLE AMATEUR RADIO EXPERIMENT-II (SAREX)

Students in the U.S. and Russia will have a chance to speak via amateur radio with astronauts aboard the Space Shuttle Discovery during STS-71. Ground-based amateur radio operators ("hams") will be able to contact the Shuttle astronauts through a direct voice ham radio link as time permits.

Space Shuttle Pilot Charlie Precourt (call sign KB5YSQ) and Mission Specialist Ellen Baker (KB5SIX) will talk to students in five schools in the U.S. and Russia using "ham radio."

Students in the following schools will have the opportunity to talk directly with orbiting astronauts for approximately 4 to 8 minutes:

- Forest Avenue School, Hudson, MA (N1QEQ)
- Suffolk Community College, Seldon, NY (N2XOU)
- Benbrook Elementary School, Benbrook, TX (N5SVW)
- Redlands High School, Redlands, CA (KO6FP)
- School Number 3 Yessentuki, Yessentuki, Russia (YA6HZ)

The radio contacts are part of the SAREX (Shuttle Amateur Radio EXperiment) project, a joint effort by NASA, the American Radio Relay League (ARRL), and the Radio Amateur Satellite Corporation (AMSAT).

The project, which has flown on 17 previous Shuttle missions, is designed to encourage public participation in the space program and support educational initiatives through a program to demonstrate the effectiveness of communications between the Shuttle and low-cost ground stations using amateur radio voice and digital techniques.

STS-71 SAREX Frequencies

Important Note: Since the flight will be the first Shuttle-Mir docking mission, and SAREX and Mir amateur radio stations usually share the same downlink frequency (145.55), the SAREX Working Group has decided to make the following SAREX frequency changes for the STS-71 mission:

For STS-71, SAREX transmissions from the Space Shuttle may be monitored on a worldwide downlink frequency of 145.84 MHz.

The voice uplink frequencies are: 144.45 and 144.47 MHz

The crew will use separate receive and transmit frequencies. **Please do not transmit on the Shuttle's downlink frequency**. The downlink is your receiving frequency. The uplink is your transmitting frequency.

Note: The astronauts will not favor any one of the above frequencies. Therefore, the ability to talk to an astronaut depends on selecting one of the above frequencies chosen by the astronaut.

Additional Information for Amateur Radio Operators

Several audio and digital communication services have been developed to disseminate Shuttle and SAREX-specific information during the flight.

The ARRL ham radio station (W1AW) will include SAREX information in its regular voice and teletype bulletins.

The amateur radio station at the Goddard Space Flight Center, (WA3NAN), will operate around the clock during the mission, providing SAREX information, retransmitting live Shuttle air-to-ground audio, and retransmitting many SAREX school group contacts.

Information about orbital elements, contact times, frequencies and crew operating schedules will be available during the mission from NASA ARRL (Steve Mansfield, 203/666-1541) and AMSAT (Frank Bauer, 301/286-8496). AMSAT will provide information bulletins for interested parties on Internet and amateur packet radio.

Current Keplerian elements to track the Shuttle are available from the NASA Spacelink computer information system (BBS), (205) 895-0028 or via Internet spacelink.msfc.nasa.gov., and the ARRL BBS (203) 666-0578.

The latest element sets and mission information are also available via the Johnson Space Center (JSC) ARC BBS or the Goddard Space Flight Center (GSFC) BBS. The JSC number is (713)244-5625, 9600 Baud or less. The GSFC BBS is available via Internet. The address is wa3nan.gsfc.nasa.gov.

The Goddard Space Flight Center amateur radio club planned HF operating frequencies:

3.860	7.18	14.29	21.39	28.65
MHz	5	5	5	0

STS-71 CREWMEMBERS

STS071-S-002 -- Crew members for the STS-71 mission and the related Mir missions assemble for a crew portrait at the Johnson Space Center (JSC). In front are, left to right, Vladimir N. Dezhurov, Robert L. Gibson and Anatoliy Y. Solovyev, mission commanders for Mir-18, STS-71 and Mir-19, respectively. On the back row are, left to right, Norman E. Thagard, Gennadiy M. Strekalov, Gregory J. Harbaugh, Ellen S. Baker, Charles J. Precourt, Bonnie J. Dunbar and Nikolai M. Budarin. In a precedent-setting flight, Thagard later this month will be launched as a guest researcher along with Dezhurov, commander, and Strekalov, flight engineer, to Russia's Mir Space Station for a three month mission, designated as Mir 18. Then in late spring, as the assignment of STS-71, the Space Shuttle Atlantis will rendezvous with the Russian Mir Space Station to pick up the Mir 18 crew and transfer cosmonauts Solovyev and Budarin to the station for the Mir 19 mission.

PHOTO CREDIT: NASA or National Aeronautics and Space Administration.

MIR-18 CREWMEMBERS

S94-34941 **--** *Astronaut Norman E. Thagard, left, poses with two Russian cosmonauts with whom he will be launched into space early next year for a three-month mission. Designated Mir-18, the mission aboard the Russian space station Mir will include Mir-18 commander Vladimir N. Dezhurov (center) and crew member Gennadiy M. Strekalov (right). Following weeks of training together in Russia, the three spent part of the late spring and early summer in training at the Johnson Space Center (JSC) in Houston, TX.*

PHOTO CREDIT: NASA or National Aeronautics and Space Administration.

MIR-19 CREWMEMBERS

S94-34942 **--** *Crewmembers for the Mir-19 mission, Anatoliy Y. Solovyev, left, mission commander and Nikolai M. Budarin flight engineer. The two cosmonauts will launch aboard space shuttle Atlantis on mission STS-71, dock with the Mir space station and replace Mir-18 cosmonauts Vladimir N. Dezhurov, mission commander, and flight engineer Gennadiy M. Strekalov who will return to Earth aboard Atlantis.*

BIOGRAPHICAL DATA – STS-71 CREWMEMBERS

ROBERT L. "HOOT" GIBSON, COMMANDER

STS-71 will be commanded by U.S. Navy Captain Robert L. Hoot Gibson, 48, who will be making his fifth spaceflight.

Gibson was born in Cooperstown, NY, but considers Lakewood, CA, to be his hometown. He received an associate degree in engineering science from Suffolk County Community College in 1966 and a Bachelor's in aeronautical engineering from California Polytechnic State University in 1969.

Gibson entered active duty with the Navy in 1969. He received primary and basic flight training at Naval Air Stations Saufley Field; Pensacola, FL; and Meridian, MS, and completed advanced flight training at the Naval Air Station at Kingsville, TX. While assigned to Fighter Squadrons 111 and 1 from April 1972 to September 1975, he saw duty aboard the USS Coral Sea and the USS Enterprise, flying combat missions in Southeast Asia. He is a graduate of the Naval Fighter Weapons School, Top Gun. Gibson returned to the United States and an assignment as an F-14A instructor pilot with Fighter Squadron 124. He also graduated from the U.S. Naval Test Pilot School, Patuxent River, MD, in June 1977, and later became involved in the test and evaluation of F-14A aircraft while assigned to the Naval Air Test Center's Strike Aircraft Test Directorate.

Gibson was selected as an astronaut in 1978, and since then has logged more than 26 days in space. His first spaceflight was as pilot of STS-41B in February 1984. The flight accomplished the deployment of two communications satellites and tested rendezvous sensors and computer programs for the first time. He next flew as commander of STS-61C, a six-day flight that included the deployment of the SATCOM KU satellite and the completion in astrophysics and materials processing. Gibson's third trip to orbit was made in December 1988 on STS-27, a classified Department of Defense mission.

He then returned to space for a fourth time on STS-47 in September 1992. The mission was a cooperative venture between the United States and Japan, focusing on more than 40 life science and materials processing experiments. From December 1992 to September 1994, Gibson served as chief of the Astronaut Office until he was selected to command the STS-71 mission.

CHARLES J. PRECOURT, PILOT

Air Force Lt. Col. Charles J. Precourt, 39, will serve as Atlantis' pilot during his second space flight.

Precourt was born in Waltham, MA, but considers Hudson, MA, to be his hometown. He earned a bachelor's degree in aeronautical engineering from the U.S. Air Force Academy in 1977, and master's degrees in engineering management from Golden Gate University, and national security affairs and strategic studies from the U.S. Naval War College in 1988 and 1990, respectively. While at the Air Force Academy, Precourt also attended the French Air Force Academy in 1976 as part of an exchange program.
Precourt graduated from Undergraduate Pilot Training at Reese Air Force Base, TX, in 1978. Initially, he flew as an instructor pilot in the T-37, and later as a maintenance test pilot in the T-37 and T-38 aircraft. From 1982 through 1984, he flew an operational tour in the F-15 Eagle at Bitburg Air Base in Germany. In 1985, he attended the U.S. Air Force Test Pilot School at Edwards Air Force Base, CA. Upon graduation he was assigned as a test pilot at Edwards where he flew F-15E, F-4, A-7 and A-37 aircraft until mid-1989, when he began studies at the U.S. Naval War College.

Precourt was selected as an astronaut candidate in 1990. His technical assignments have included duties in the Astronaut Office operations Development Branch, working on ascent, entry and launch abort issues. Precourt flew his first space mission as a mission specialist on STS-55 in April 1993. The German-sponsored mission included almost 90 experiments designed to investigate life sciences, material sciences, physics, robotics and astronomy. At the conclusion of the flight, he had spent about 240 hours in orbit.

BIOGRAPHICAL DATA – STS-71 CREWMEMBERS

ELLEN S. BAKER, MISSION SPECIALIST 1

Ellen S. Baker, M.D., 42, will be making her third spaceflight as Mission Specialist 1 for STS-71.

Baker was born in Fayetteville, NC, but considers New York City to be her hometown. She received a bachelor's degree in geology from the State University of New York at Buffalo and a doctorate of medicine degree from Cornell University in 1978. After completing medical school, Baker trained in internal medicine at the University of Texas Health Science Center, San Antonio, TX. She was certified by the American Board of Internal Medicine in 1981.

Following her residency, Baker joined NASA as a medical officer at the Johnson Space Center. That same year she graduated from the Air Force Medicine Primary Course at Brooks Air Force Base in San Antonio. Baker was selected as an astronaut candidate in 1985. Her technical assignments have included working with flight crew procedures, flight software verification, operations and engineering support activities and Space Station operation issues. She also has served as chief of the Astronaut Appearance Office.

Baker has logged more than 451 hours in space. Her first mission was STS-34 in October 1989 which successfully started the Galileo spacecraft on its journey to Jupiter. Her second mission was STS-50 in June/July 1992. The STS-50 crew spent about two weeks in orbit to conduct a series of scientific experiments involving crystal growth, fluid physics, fluid dynamics, biological science and combustion science.

GREGORY J. HARBAUGH, MISSION SPECIALIST 2

Two-time Shuttle veteran Gregory J. Harbaugh, 39, will serve as Mission Specialist 2.

Harbaugh was born in Cleveland OH, but considers Willoughby, OH, his hometown. He holds a bachelor's degree in aeronautical and astronautical engineering from Purdue University, and a master's degree in physical science from the University of Houston-Clear Lake.

Harbaugh came to the Johnson Space Center after graduation from Purdue. Since 1978, he has held engineering and technical management positions in Space Shuttle flight operations. He also supported missions as a Data Processing Systems Officer from the Mission Control Center for most of the first 25 Shuttle flights.

Selected as an astronaut in June 1987, Harbaugh's technical assignments have included work with the Shuttle Avionics Integration Laboratory, the Shuttle Remote Manipulator System and telerobotics systems development for Space Station. He also has supported the Hubble Space Telescope servicing mission development and extravehicular activity assessment for the international Space Station.

Harbaugh's first mission, STS-39 in April/May 1991, was an eight-day unclassified Department of Defense mission involving research for the Strategic Defense Initiative. His second flight was STS-54 in January 1993. During the six-day mission, the TDRS-F satellite was deployed and Harbaugh participated in a 4-hour, 28-minute space walk. Harbaugh also trained as a backup EVA crew member for the Hubble Space Telescope Servicing mission. With the two missions, Harbaugh has logged more than 343 hours in space.

BIOGRAPHICAL DATA – STS-71 CREWMEMBERS

BONNIE DUNBAR, MISSION SPECIALIST 3

After training as backup to Mir 18 crew member Norm Thagard, Bonnie Dunbar, Ph.D., 46, will visit the Russian space station as STS-71's Mission Specialist 3.

Dunbar, a native of Sunnyside, WA, received bachelor's and master's degrees in ceramic engineering from the University of Washington in 1971 and 1975, respectively; and a doctorate in biomedical engineering from the University of Houston in 1983.

Following graduation in 1971, Dunbar worked for Boeing Computer Services for two years as a systems analyst. In 1975, she was invited to participate in research at Harwell Laboratories in Oxford, England, as a visiting scientist.

Following her work in England, she accepted a senior research engineer position with Rockwell International Space Division in Downey, CA, where her responsibilities included developing equipment and processes for the manufacture of the Space Shuttle thermal protection system. She currently serves as an adjunct assistant professor in mechanical engineering at the University of Houston and serves on the Bioengineering Advisory Group.

In 1978, Dunbar accepted a position as a payload officer/flight controller at the Johnson Space Center. She served as a guidance and navigation officer for the Skylab reentry mission in 1979 and was subsequently designated project officer/payload officer for the integration of several Shuttle payloads.

Selected as an astronaut in 1981, Dunbar is a veteran of three space flights and has logged more than 761 hours in space. Her first flight, STS-61A, was a cooperative Spacelab mission with West Germany. The payload included more than 75 scientific experiments in the areas of physiological sciences, materials science, biology and navigation. In January 1990, Dunbar served as a mission specialist on STS-32. During the 10-day mission, crew members deployed the Syncom IV-F5 satellite and retrieved the Long Duration Exposure Facility. Dunbar also was principal investigator for the Microgravity Disturbance Experiment using the Fluids Experiment Apparatus on the mission.

The third mission was STS-50 in June-July 1990 for which she served as payload commander. The crew operated around the clock for 13 days performing experiments in scientific disciplines such as protein crystal growth, electronic and infrared detector crystal growth, surface tension physics, zeolite crystal growth and human physiology.

For the past year, Dunbar has been training in Star City, Russia, as back-up cosmonaut researcher for the Mir 18 mission. Following the completion of her training in Russia, she returned to Houston to train for the STS-71 flight.

BIOGRAPHICAL DATA – MIR-18 CREWMEMBERS
(returning on Atlantis)

VLADIMIR N. DEZHUROV, MIR 18 COMMANDER

Dezhurov, 32, is making his first spaceflight as commander of the Mir 18 mission. He is a lieutenant colonel in the Air Force. Born in the Yavas settlement of the Zubovo-Polyansk district in Moldovia, Russia, Dezhurov graduated from the S. I. Gritsevits Kharkov Higher Military Aviation School in 1983 with a pilot-engineer's diploma. After graduating, he served as a pilot and senior pilot in the Russian Air Force. In 1987, he was assigned to the Cosmonaut Training Center and underwent the general space training from December 1987 to June 1989. Since then he has continued training as a member of a group of test cosmonauts. He also has been a correspondence student at the Yuri A. Gagarin Air Force Academy since 1991.

GENNADY M. STREKALOV, MIR 18 FLIGHT ENGINEER

Four-time space veteran Strekalov, 54, is an instructor-test cosmonaut and department head at NPO Energia. Born in Mytishchi in the Moscow Region of Russia, Strekalov graduated from the N. E. Bauman Moscow Higher Technical School in 1965 with an engineer's diploma. Since then, he has worked at Energia and has been involved in experimental investigations and the testing of space technology. As part of an operations group, he participated in mission control for flights of scientific-research craft belonging to the Academy of Science. Strekalov's first spaceflight was a two-week mission in 1980 to the Salyut space station, completing an experimental flight aboard the Soyuz T-3 spacecraft. He visited Salyut again in April 1983 and in April 1984. From Aug. 1 to Dec. 10, 1990, Strekalov completed his fourth spaceflight as the flight engineer on the seventh primary expedition to the Mir orbital complex. At the completion of that flight, he had accumulated 153 days in space.

NORMAN E. THAGARD, M.D., MIR 18 COSMONAUT RESEARCHER

Four-time Shuttle veteran Thagard became the first American to ride on board a Russian launch vehicle when he was launched to the Russian space station on March 14, 1995.

Born in Marianna, FL, Thagard considers Jacksonville, FL, to be his hometown. He attended Florida State University where he received bachelor's and master's degrees in engineering science in 1965 and 1966, respectively. In September 1966, he entered active duty with the U.S. Marine Corps Reserve. He achieved the rank of captain in 1967, was designated a naval aviator in 1968, and was then assigned to duty flying F-4s at the Marine Corps Air Station in Beaufort, SC. He flew 163 combat missions in Vietnam before returning to the United States and an assignment as an aviation weapons division officer at the Beaufort Air Station. Thagard resumed his academic studies in 1971 and received a doctor of medicine degree from the University of Texas Southwestern Medical School in 1977. Prior to his joining NASA, he was interning in the Department of Internal Medicine at the Medical University of South Carolina.

Thagard was selected as an astronaut candidate in 1978. His first space mission was as part of the crew of STS-7 in June 1983. During the mission, crew members deployed two satellites, deployed and retrieved the Shuttle Pallet satellite, and conducted a series of scientific investigations. His second flight was STS-51B, the Spacelab-3 science mission, in April/May 1985. Thagard's duties on the mission included deploying the NUSAT satellite, caring for animals in the Research Animal Holding Facility and operating a variety of other experiments. Thagard went to orbit for a third time in May 1989 during the STS-30 mission. The mission's highlight was the deployment of the Magellan probe, the first U.S. planetary mission since 1978. His fourth flight in January 1992 was STS-42. The flight, called the International Microgravity Laboratory-1 mission, featured 55 experiments from 11 countries, which studied the effects of microgravity on material processing and life sciences. With the completion of his fourth mission, Thagard logged over 604 hours in space; however, because of his three-month mission on Mir, he now holds the American record for the most time spent on orbit.

BIOGRAPHICAL DATA – MIR-19 CREWMEMBERS

ANATOLY Y. SOLOVYEV, MIR 19 COMMANDER

During the trip to Mir, Atlantis also will carry Mir 19 Commander Anatoliy Y. Solovyev and Flight Engineer Nikolai M. Budarin.

Solovyev, 47, served from 1972 to 1976 as a senior pilot and group commander in the Far Eastern Military District. Since August 1976, he has been a student-cosmonaut at the Yuri A. Gagarin Cosmonaut Training Center, completing his general space training in 1979. He is a test pilot third class and a test cosmonaut.

In 1988, he was the commander of a Soviet-Bulgarian crew for an expedition that visited the Mir station. The flight lasted nine days. Then, from Feb. 11 to Aug. 9, 1990, Solovyev accomplished a 179-day flight on board the Mir orbital complex as commander for the sixth primary expedition. During the mission, the crew conducted a series of technological, geophysical and biomedical investigations; performed two spacewalks; and placed the Kristall module into service.

Solovyev's third flight was a 189-day mission to Mir from July 27, 1992, to Feb. 1, 1993. Mission activities included the completion of a Russian-French science program with microgravity, biology, medical, biotechnology and other investigations.

NIKOLAI M. BUDARIN, MIR 19 FLIGHT ENGINEER

This will be the first space flight for Budarin, flight engineer for Mir 19.

Budarin, 42, received a mechanical engineering degree from the S. Ordzhonikidze Moscow Aviation Institute in 1979. He then joined NPO Energia where he was involved in experimental investigations and testing of space technology. In 1989, Budarin was enrolled in a cosmonaut detachment as a candidate test cosmonaut, completing his training in 1991. He is a qualified test cosmonaut. He also has experience working with the primary operations group for space mission control.

When Atlantis leaves, Solovyev and Budarin will stay at the Mir Station. The Mir 18 crew consisting of Commander Vladimir N. Dezhurov, Flight Engineer Gennadiy M. Strekalov and U.S. Astronaut and Cosmonaut Researcher Norman E. Thagard, M.D., will return to Earth with the STS-71 crew.

CHRONOLOGY OF SELECTED HIGHLIGHTS IN THE FIRST 100 AMERICAN HUMAN SPACEFLIGHTS, 1961-1995

May 5, 1961	*Freedom 7,* the first piloted Mercury spacecraft (No. 7) carrying Astronaut Al Shepard Jr., was launched from Cape Canaveral by Mercury-Redstone (MR-3) vehicle, to an altitude of 115,696 feet and a range of 302 miles. It was the, first space flight involving human beings. Shepard demonstrated that individuals can control a vehicle during weightlessness and high G stresses, and significant scientific data were acquired. He reached a speed of 5,100 miles per hour and his flight lasted 14.8 minutes.
Feb. 20, 1962	John Glenn became the first American to circle the Earth, making three orbits in his *Friendship* 7 Mercury spacecraft. Despite some problems with spacecraft -- Glenn flew parts of the last two orbits manually because of an autopilot failure and left his jettisoned retrorocket pack attached to his capsule during reentry because of a loose heat shield -- this flight was enormously successful. The public, more than celebrating technological success, embraced Glenn as a personification of heroism and dignity. Among other engagements, Glenn addressed a joint session of Congress and participated in several ticker-tape parades around the country.
May 15-16, 1963	The capstone of Project Mercury, the flight of *Faith* 7, took place on this date with the flight of astronaut L. Gordon Cooper, who circled the Earth 22 times in 34 hours.
Mar. 23, 1965	Following two unoccupied orbital and suborbital test flights, the first operational mission of Gemini took place on March 23, 1965. Mercury astronaut Gus Grissom command mission, with John W. Young, a Naval aviator chosen as an astronaut in 1962, accompanying him.
Jun. 23-25, 1965	The second piloted Gemini mission, GT-4, stayed aloft for four days and as Edward H. White II performed the first extravehicular activity (EVA) or spacewalk by an American.
Oct. 11-22, 1968	The first piloted flight of the Apollo spacecraft, Apollo 7, and Saturn 1B launch vehicle, this flight involved astronauts Walter M. Schirra Jr., Donn F. Eisele, and Cunningham who tested hardware in Earth orbit.
Dec. 21-27, 1968	On December 21, 1968, Apollo 8 took off atop a Saturn V booster from the Kennedy Space Center with three astronauts aboard -- Frank Borman, James A. Lovell Jr. and William A. Anders -- for a historic mission to orbit the Moon. At first it was planned as a mission to test Apollo hardware in the relatively safe confines of low Earth orbit, but a senior engineer, George M. Low of the Manned Spacecraft Center at Houston, (renamed the Johnson Space Center in 1973), and Samuel C. Phillips, Apollo Program Manager at NASA headquarters, pressed for approval to make it a circumlunar The advantages of this could be important, both in technical and scientific knowledge gained as well as in a public demonstration of what the U.S. could achieve. In the summer of 1968 Low broached the idea to Phillips, who then carried it to the administrator, and in November the agency reconfigured the mission for a lunar trip. After Apollo 8 made one and a half Earth orbits, its third stage began a burn to put the spacecraft on a lunar trajectory. As it traveled outward the crew focused a portable television camera on Earth and for the first time humanity saw its home from afar, a tiny, lovely, and fragile "blue marble" hanging

in the blackness of space. When it arrived at the Moon on Christmas Eve this image of Earth was even more strongly reinforced when the crew sent images of the planet back while reading the first part of the Bible -- "And God created the heavens and the Earth, and the Earth was without form and void" -- before sending Christmas greetings to humanity. The next day they fired the boosters for a return flight and "splashed down" in the Pacific Ocean on December 27. It was an enormously significant accomplishment coming at a time when American society was in crisis over Vietnam, race relations, urban problems, and a host of other difficulties. And if only for a few moments the nation united as one to focus on this epochal event. Two more Apollo missions occurred before the climax of the program, but they did little more than confirm that the time had come for a lunar landing.

Jul. 16-24, 1969 The first lunar landing mission, Apollo 11 lifted off on July 16, 1969, and after confirming that the hardware was working well began the three day trip to the Moon. At 4:18 p.m. EST on July 20, 1969, the Lunar Module -- with astronauts Neil A. Armstrong and Edwin E. Aldrin -- landed on the lunar surface while Michael Collins orbited overhead in the Apollo command module. After checkout, Armstrong set foot on the surface, telling the millions of listeners that it was "one small step for man -- one giant leap for mankind." Aldrin soon followed him out and the two plodded around the landing site in the 1/6 lunar gravity, planted an American flag but omitted claiming the land for the U.S. as had routinely been done during European exploration of the Americas, collected soil and rock samples, and set up some experiments. The next day they launched back to the Apollo capsule orbiting overhead and began the return trip to Earth, "splashing down" in the Pacific on July 24.

Apr. 11-17,1970 The flight of Apollo 13 was one of the near disasters of the Apollo flight program. At 56 hours into the flight, an oxygen tank in the Apollo service module ruptured and damaged several of the power, electrical, and life support systems. People throughout the world watched and waited and hoped as NASA personnel on the ground and the crew, well on their way to the Moon and with no way of returning until they went around it, worked together to find a way safely home. While NASA engineers quickly determined that sufficient air, water, and electricity did not exist in the Apollo capsule to sustain the three astronauts until they could return to Earth, they found that the Lunar Module -- a self-contained spacecraft unaffected by the accident -- could be used as a "lifeboat" to provide austere life support for the return trip. It was a close-run thing, but the crew returned safely on April 17, 1970. The near disaster served several important purposes for the civil space program -- especially prompting reconsideration of the propriety of the whole effort while also solidifying in the popular mind NASA's technological genius.

Jul. 26-Aug. 7, 1971 The first of the longer, expedition-style lunar landing missions, Apollo 15 was the first to include the lunar rover to extend the range of the astronauts on the Moon. They brought back one of the prize artifacts of the Apollo program, a sample of ancient lunar crust called the "Genesis Rock."

Dec. 7-19, 1972 Apollo 17 was the last of the Apollo missions to the Moon, and the only one to include a scientist -- astronaut/geologist Harrison Schmitt -- as a member of the crew.

May 25-Jun. 22, 1973 Following the launch of the orbital workshop, Skylab, on May 14, 1973, the Skylab mission began. The workshop had developed technical problems due to vibrations during lift-off and the meteoroid shield -- designed also to shade Skylab's workshop from Sun's rays -- ripped off, taking with it one of the spacecraft's two solar panels, another piece wrapped around the other panel keeping it from properly deploying. In spite of this, the space station achieved a near-circular orbit at the desired altitude of miles. While NASA technicians worked on a solution to the problem, an intensive ten-day period followed before the Skylab 2 crew launched to repair the workshop. After substantial repairs requiring extravehicular activity (EVA), including deployment of parasol sunshade that cooled the inside temperatures to 75 degrees Fahrenheit, by June 4 the workshop was in full operation. In orbit the crew conducted solar astronomy and Earth resources experiments, medical studies, and five student experiments. This crew made 404 orbits and carried out experiments for 392 hours, in the process making EVAs totaling six hours and 20 minutes. The first group of astronauts returned to Earth on June 22, 1973, and two other Skylab missions followed.

Jul. 15-24, 1975 The Apollo-Soyuz Test Project was the first international human space flight, taking place at the height of the détente between the United States and the Soviet Union during the mid-1970s. It was specifically designed to test the compatibility of rendezvous docking systems for American and Soviet spacecraft, and to open the way for international space rescue as well as future joint missions. To carry out this mission existing American Apollo and Soviet Soyuz spacecraft were used. The Apollo spacecraft was nearly identical to the one that orbited the Moon and later carried astronauts to Skylab, while the Soyuz craft was the primary Soviet vehicle used for cosmonaut flight since its introduction in 1967. A universal docking module was designed and constructed by NASA to serve as an airlock and transfer corridor between the two craft. Astronauts Thomas P. Stafford, Vance D. Brand, and Donald K. Slayton took off from Kennedy Space Center on July 15, to meet the already orbiting Soyuz spacecraft. Some 45 hours later the two craft rendezvoused and docked, and then Apollo and Soyuz crews conducted a variety of experiments over a two-day period. After separation, the Apollo vehicle remained in space an additional six days while Soyuz returned to Earth approximately 4 hours after separation. The flight was more a symbol of the lessening of tensions the two superpowers than a significant scientific endeavor, a sharp contrast with competition for international prestige that had fueled much of the space activities of both nations since the late 1950s.

Apr. 12, 1981 Astronauts John W. Young and Robert L. Crippen flew Space Shuttle *Columbia on* the first flight of the Space Transportation System (STS-1). *Columbia*, which takes its from three famous vessels including one of the first U.S. Navy ships to circumnavigate the globe, became the first airplane-like craft to land from orbit for reuse when it touched down at Edwards Air Force Base in southern California at approximately 10:21 a.m. Pacific Standard Time on April 14th after a flight of two days, six hours and almost 21 minutes. The mission also was the first to employ both liquid- and solid-propellant engines for the launch of a spacecraft carrying humans.

Jun. 18, 1983 Astronauts Robert L. Crippen and Frederick H. Hauck piloted Space Shuttle *Challenger* (STS-7) on a mission to launch two communications satellites and the reusable Shuttle Pallet Satellite (SPAS 01). Sally K. Ride, one of three mission specialists on the first Shuttle flight with five crewmembers, became the first American woman astronaut. *Challenger* was named after the H. M. S. *Challenger*, an English research vessel operating from 1872 to 1876.

Aug. 30, 1983 Astronauts Richard H. Truly and Daniel C. Brandenstein piloted Space Shuttle *Challenger* (STS-8) on another historic mission, carrying the first black American astronaut, Guion S. Bluford, into space as a mission specialist. The astronauts launched communications satellite Insat 1B into orbit.

Nov. 28, 1983 Astronauts John W. Young and Brewster H. Shaw Jr. piloted Space Shuttle *Columbia* (STS-9) on a mission that carried the first non-U. S. astronaut to fly in the U.S. space program, West German Ulf Merbold. *Columbia* also transported Spacelab 1, the first flight of this laboratory in space, carrying more than 70 experiments in 5 areas of scientific research: astronomy and solar physics, space plasma physics, atmospheric physics and Earth observations, life sciences, and materials science.

Jan. 28, 1986 The Space Shuttle *Challenger,* STS-51L, was tragically destroyed and its crew of seven was killed, during its launch from the Kennedy Space Center about 11:40 a.m. The explosion occurred 73 seconds into the flight as a result of a leak in one of two Solid Rocket Boosters that ignited the main liquid fuel tank. The crewmembers of the *Challenger* represented a cross-section of the American population in terms of race, gender, geography, background, and religion. The explosion became one of the most significant events of the 1980s, as billions around the world saw the accident on television and empathized with any one of the several crewmembers killed. The disaster prompted a thorough review of the shuttle program and NASA overall, leading to substantive reforms in the management structure, safety program, and procedures of human spaceflight.

Apr. 24-29, 1990 During the flight of the Space Shuttle *Discovery* (STS-31) the crew deployed the Hubble Space Telescope. Soon after deployment, controllers found that the telescope was flawed by a "spherical aberration," a mirror defect only 1/25th the width of a human hair, that prevented Hubble from focusing all light to a single point. At first many believed that the spherical aberration would cripple the 43-foot-long telescope, and NASA received considerable negative publicity, but soon scientists found a way with computer enhancement to work around the abnormality and engineers planned a servicing mission to fully correct it with an additional instrument. Even with the aberration, Hubble made many important astronomical discoveries, including striking images of galaxy M87, providing evidence of a potentially massive black hole.

Dec. 2-12,1993 Astronauts Richard O. Covey and Kenneth D. Bowersox piloted Space Shuttle *Endeavour* (STS-61) on a highly successful mission to service the optics of the Hubble Space Telescope (HST) and perform routine maintenance on the orbiting observatory. Following a precise and flawless rendezvous, grapple, and berthing of the telescope in the cargo bay of the Shuttle, the *Endeavour* flight crew, in concert with controllers at Johnson Space Center, Houston, Texas, and Goddard Space Flight Center, Greenbelt, Maryland, completed all eleven planned servicing tasks during five extravehicular activities for full accomplishment of all STS-61 servicing objectives. This included installation of a new Wide Field & Planetary Camera and sets of corrective optics for all the other instruments, as well as replacement of faulty solar arrays, gyroscopes, magnetometers, and electrical components to restore the reliability of the observatory subsystem. *Endeavour* then provided HST with a reboost into a 321-nautical-mile, nearly circular orbit. Re-deployment of a healthy HST back into orbit using the shuttle robotic arm occurred at 5:26 a.m. EST on December 10th, and the telescope was once again a fully operational, free-flying spacecraft with vastly improved optics. Orbital verification of HST's improved capabilities occurred in early Jan., well ahead of the March schedule. *Endeavour,* the newest of the orbiters, was named after the eighteenth century vessel captained by British explorer Capt. James Cook. The new Shuttle craft took its maiden voyage in May 1992.

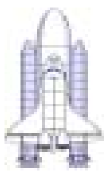
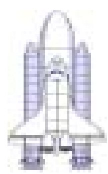
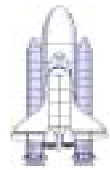
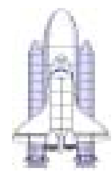
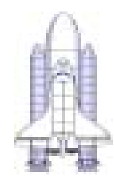
Feb. 3-11, 1994 Astronauts Charles F. Bolden and Kenneth S. Reightler Jr., flew Space Shuttle *Discovery* (STS-60) on a historic mission featuring the first Russian cosmonaut to fly on a U.S. mission in space, Mission Specialist Sergei K. Krikalev, veteran of two lengthy stays aboard the Russian Mir Space Station. This mission underlined the newly inaugurated cooperation in space between Russia and the U.S., featuring Russia's becoming an international partner in the international space station effort involving the U.S. and its international partners.

Feb. 3-11, 1995 Exactly one year after a major cooperative flight with the Russians in STS-60, NASA's Space Shuttle *Discovery* , this time STS-63, flew another historic mission featuring the flyby of the Russian Mir Space Station. It also featured the first time that a woman pilot, Eileen M. Collins, flew the Space Shuttle.

ZH/Roger Launius/202-358-0383/June 7, 1995

SHUTTLE FLIGHTS AS OF JUNE 1995

68 TOTAL FLIGHTS OF THE SHUTTLE SYSTEM -- 43 SINCE RETURN TO FLIGHT

OV-102 **Columbia** **(17 flights)**	**OV-099** **Challenger** **(10 flights)**	**OV-103** **Discovery** **(20 flights)**	**OV-104** **Atlantis** **(13 flights)**	**OV-105** **Endeavour** **(8 flights)**
		STS-63 02/03/95 - 02/11/95		
		STS-64 09/09/94 - 09/20/94		
		STS-60 02/03/94 - -2/11/94		
STS-65 07/08/94 0 07/23/94		STS-51 09/12/93 - 09/22/93		
STS-62 03/04/94 - 03/18/94		STS-56 04/08/83 - 04/17/93		
STS-58 10/18/93 - 11/01/93		STS-53 12/02/92 - 12/09/92		
STS-55 04/26/93 - 05/06/93		STS-42 01/22/92 - 01/30/92		
STS-52 10/22/92 - 11/01/92		STS-48 09/12/91 - 09/18/91	STS-66 11/03/94 - 11/14/94	
STS-50 06/25/92 - 07/09/92		STS-39 04/28/91 - 05/06/91	STS-46 07/31/92 - 08/08/92	
STS-40 06/05/91 - 06/14/91		STS-41 10/06/90 - 10/10/90	STS-45 03/24/92 - 04/02/92	
STS-35 12/02/90 - 12/10/90	STS-51L 01/28/86	STS-31 04/24/90 - 04/29/90	STS-44 11/24/91 - 12/01/91	
STS-32 01/09/90 - 01/20/90	STS-61A 10/30/85 - 11/06/85	STS-33 11/22/89 - 11/27/89	STS-43 08/02/91 - 08/11/91	
STS-28 08/08/89 - 08/13/89	STS-51F 07/29/85 - 08/06/85	STS-29 03/13/89 - 03/18/89	STS-37 04/05/91 - 04/11/91	STS-67 03/02/95 - 03/18/95
STS-61C 01/12/86 - 01/18/86	STS-51B 04/29/85 - 05/06/85	STS-26 09/29/88 - 10/03/88	STS-38 11/15/90 - 11/20/90	STS-68 09/30/94 - 10/11/94
STS-9 11/28/83 - 12/08/83	STS-41G 10/05/84 - 10/13/84	STS-51-I 08/27/85 - 09/03/85	STS-36 02/28/90 - 03/04/90	STS-59 04/09/94 - 04/20/94
STS-5 11/11/82 - 11/16/82	STS-41C 04/06/84 - 04/13/84	STS-51G 06/17/85 - 06/24/85	STS-34 10/18/89 - 10/23/89	STS-61 12/02/93 - 12/13/93
STS-4 06/27/82 - 07/04/82	STS-41B 02/03/84 - 02/11/84	STS-51D 04/12/85 - 04/19/85	STS-30 05/04/89 - 05/08/89	STS-57 06/21/93 - 07/01/93
STS-3 03/22/82 - 03/30/82	STS-8 08/30/83 - 09/05/83	STS-51C 01/24/85 - 01/27/85	STS-27 12/02/88 - 12/06/88	STS-54 01/13/93 - 01/19/93
STS-2 11/12/81 - 11/14/81	STS-7 06/18/83 - 06/24/83	STS-51A 11/08/84 - 11/16/84	STS-61B 11/26/85 - 12/03/85	STS-47 09/12/92 - 09/20/92
STS-1 04/12/81 - 04/14/81	STS-6 04/04/83 - 04/09/83	STS-41D 08/30/84 - 09/05/84	STS-51J 10/03/85 - 10/07/85	STS-49 05/07/92 - 05/16/92